# CARBON BUSTERS

## ASHRAE LowDown Showdown

**2021 Building Performance Analysis Conference**

**Building Type: Residential Care Center**

**Total Floor Area: 75,000 ft2**

**Location: Puerto Rico**

**Total Site Energy Usage**

2,340,000 kBtu

**Site EUI**

31 kBtu/ft²

**Source EUI**

-26 kBtu/ft²

**Total Operational Carbon**

- kgCO2e/ft²

**Total Energy Storage Capacity**

500,000 kBtu

**Annual Water Usage**

- Gallons

**Annual Energy Costs**

- $/ft²

**Annual Water Costs**

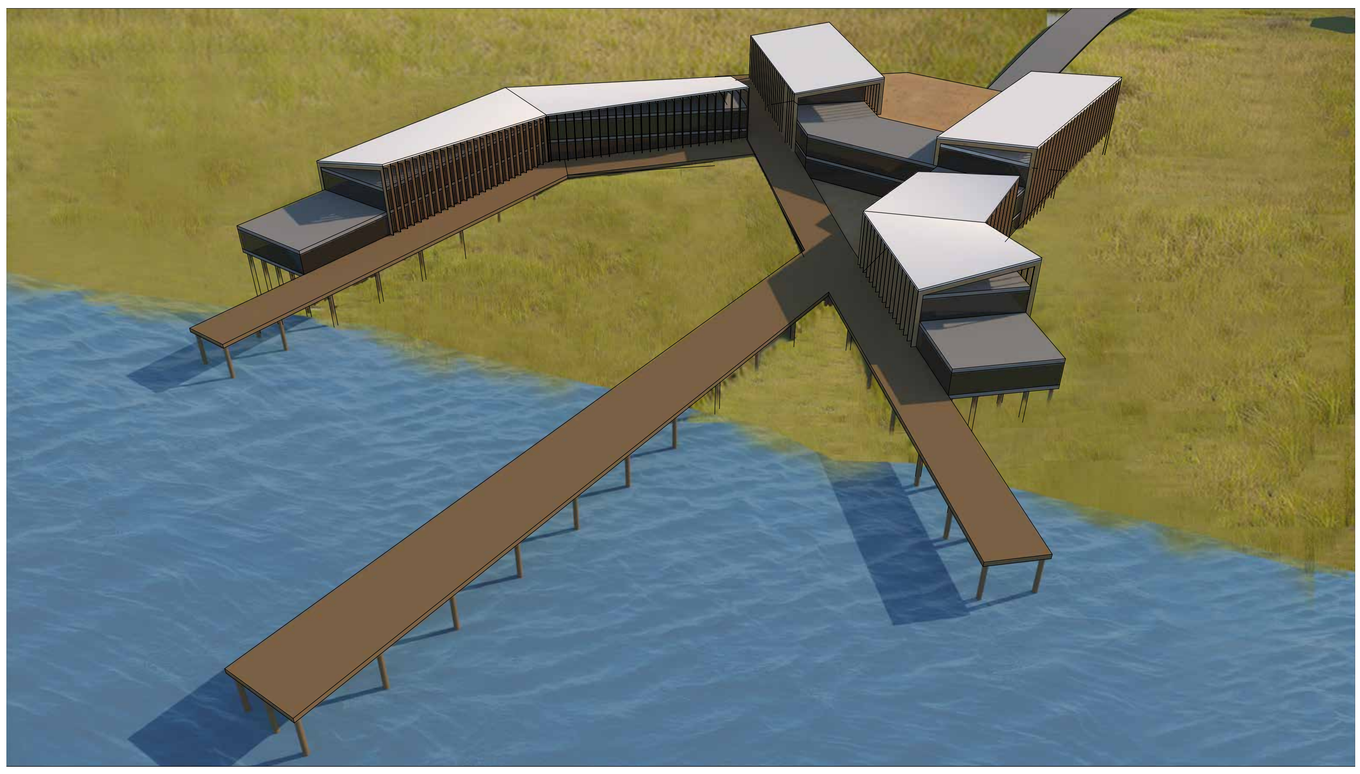
- $/ft²

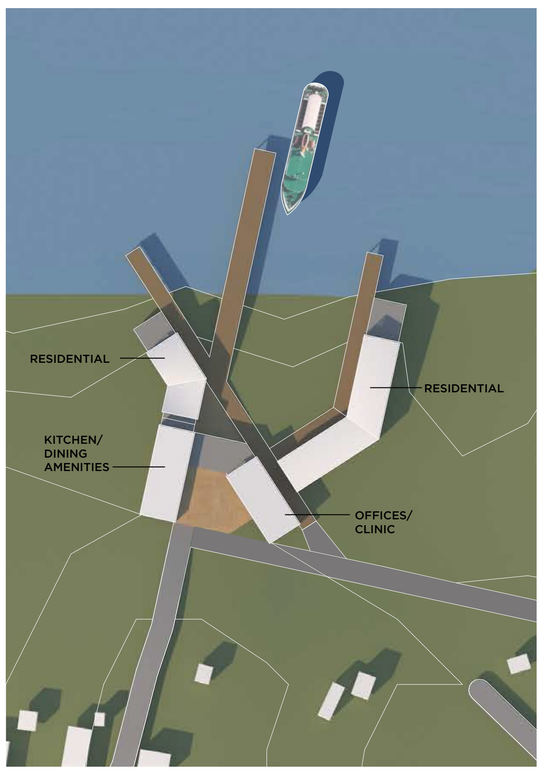
**Total Annual Costs**

- $/ft²

**Total Energy Generation**

4,300,000 kBtu



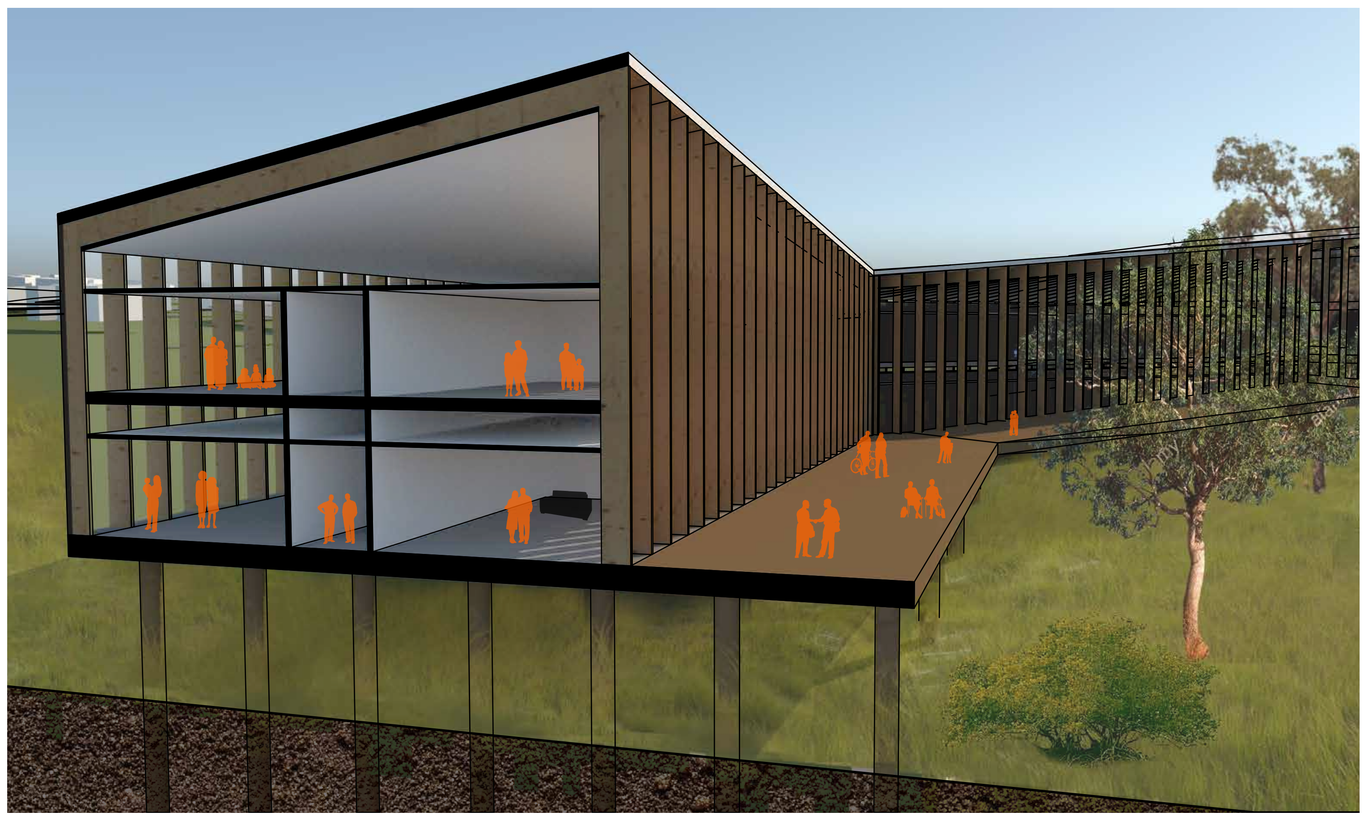


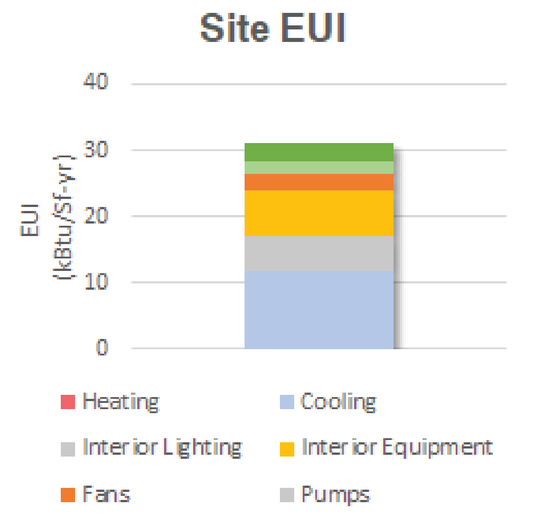

## Design Description

The project is situated on the northern coast of Vieques, a small island located east of mainland Puerto Rico. Our site sits in the Quebrada Cofi Valley located about a half mile west of the dense city center of the Isabell II Barrio. Puerto Rico is an island that is no stranger to natural disasters and Vieques, located further east of the mainland, receives the brunt of damages when it comes to hurricanes and tropical storms. In our site selection, we wanted to directly respond to the under-resourced and more vulnerable part of Puerto Rico. The site aims to serve as an additional hub between the mainland and Vieques' smaller local communities who need refuge or passage in times of emergency.

## Energy Savings Strategies

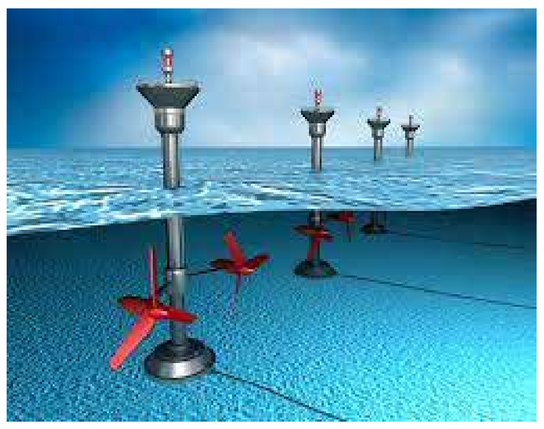
This building is to be powered solely by renewable energy: PV, tidal, and offshore wind. The renewable energy generation is designed with enough capacity to power the building in an isolated manner during emergencies for 3 months, while also still exporting surplus renewable energy to the local community! Based on 2-axis tracking in this region, the average annual AC energy density is approximately 334 kWh/m^2, yielding an average annual energy production of 1,250,000 kWh/yr using 90% of the roof for solar. The secondary form of power production shall be an off-shore wind turbine. The hub height, 94 meters, and rotor diameter, 95 meters, were optimized in relation to one another to produce an annual energy production of ~10,000,000 kWh/year at a SPB of 1.05 years. Lastly, a series of ten, 10m diameter, tidal turbines are located in the current beneath the wind turbine, optimized to fit within the footprint of the wind turbine. In total, 3,000,000 kWh/yr of tidal energy can be produced at a SPB of 2.1 years. The building is designed to use approximately 2,342,000 kBtu/year of electricity while producing 4,298,000 kBtu/yr of electricity, making it net energy positive by nearly a factor of 2! Excess energy can be exported to the local community, or stored onsite with H2O electrolyzers as hydrogen to be used later by Fuel Cells. All AHUs are dedicated outdoor air systems that provide ventilation air to the zones. Dual regenerative core air-side energy recovery allows for latent and sensible heat recovery of up to 95% in the winter, removing the need for humidification, and reducing the supplemental heating load to the point where it can be satisfied using waste heat. A second desiccant wheel has been added for reheat or added dehumidification. Heat recovery chillers are used to balance simultaneous heating and cooling loads. All units are over-sized in order to meet the needs of an extreme heat event or period of extended cold weather. All supplemental heating and cooling shall come from the same heat pumps, which shall reject or reclaim heat from heat exchangers connected to the local water.






**Solar Energy: 3,735 m2 2-axis tracking array**
Peak: 561 kW
Annual: 1,250,000 kWh

**Offshore Wind Energy: One 91m Diameter Turbine**
Peak: 1,142 kW
Annual: 10,000,000 kWh



**Tidal Energy: Ten(10) 10m Diameter Turbines**
Peak: 86 kW
Annual: 750,000 kWh

## Team


Energy Modeling/Engineering
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